

## Annual Project Reports

### Technology Workforce Development Grants 2003

SUMMER 2006

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## TWD 2003 Computer Sciences

### **Texas A&M University-Corpus Christi; More Attention for Retention and Recruitment, (011161-CS2003-000)**

With the TWD project More Attention for Recruitment and Retention, Texas A&M University-Corpus Christi successfully implemented strategies that benefited students and positively impacted the critical decline in computer science majors. In the area of recruitment, two strategies were implemented: Traveling to high schools to speak directly to students and offering scholarships to community college transfer students into computer science. By combining TWD funds with federal funds, the total number of high school students directly contacted was 4,172. Of this total, 43 percent were female students and 70 percent were Hispanic. The result of this aggressive effort was to increase matriculation of incoming freshmen at a time when enrollments are continuing to decline around the country. In the area of retention, two strategies were implemented: Tutoring of freshmen and sophomore students and establishing undergraduate research fellowships positions for computer science majors. With TWD funding, computer science tutoring was conducted for the first time in the University's Tutoring and Learning Center. However, the real success was the implementation of undergraduate research fellow positions that allowed several undergraduate students to work on research projects with various faculty researchers in computer science. This work provided motivation to continue undergraduate studies, financial support and enticement to continue study in graduate school.

The table below shows how the successful recruitment effort has increased freshmen enrollment over the last year and a half. The increases range from 12 percent to 16 percent.

<b>FRESHMEN ENROLLMENT IN COMPUTER SCIENCE</b>						
	<b>Fall</b>			<b>Spring</b>		
Year	2003	2004	2005	2004	2005	2006
Count	65	57	64	34	38	44
Delta		-8	+7		+4	+6
Percent		-12%	+12%		+12%	+16%

The summary costs for student support can be seen below:

	High School	Entering	Progressing	Advanced
Students Impacted	4172	726	147	314
Cost Per Category	\$44,388	\$81,673	\$15,979	\$35,510
Cost Per Student	\$11	\$112	\$109	\$113

Sustainability has been achieved in a variety of ways. In the area of retention, the Tutoring and Learning Center has received University approval to fund a computer science tutor without TWD funding. Undergraduate research fellow efforts will continue through other grants since this strategy was shown to be very successful. The success of the recruitment effort will continue with federal and other University funds.

A computer science freshmen seminar was instituted in order to build a learning community of entering students to facilitate the academic support of new students. Plans are underway to create a new introduction to computer science course for entering freshmen to provide them the necessary skills to succeed in the first undergraduate computer science course in the degree plan for all computer science majors. This

course will increase the success rate of freshmen who received no computer science instruction in high school.

### **Texas Engineering Experiment Station; Increasing Computer Science Retention with Peer Teachers and Learning Modules (010366-CS2003-0000)**

#### Peer Teacher Program:

This is a continuation of the Peer Teaching Program from Grant 2003. Successful students hired to return to the lab and classroom to assist younger students. This program has been very well accepted by students, peer teachers, and faculty. When presented at the best practices conference in January 2006, the Peer Teacher program was selected by attendees as the "best of the best practices." The program has been expanded to include all courses in the department. The program will undergo side by side evaluation this year under another grant. Cost for strategy: \$199,328; cost per student: \$75.88

#### Module Development:

This is a continuation of the Module Development Program from Grant 2002. computer learning modules for Texas A&M University and high school students. Several modules have been developed and tested in five high schools in spring 2006. Students and teachers liked the modules, but there were some problems, particularly with the learning IDE and because of installation and security procedures in the high schools. During the past summer, many problems were fixed, a better IDE was installed and the method of delivery was changed to overcome the problems mentioned above. Modules will undergo additional testing and then be distributed to high school students across the State. Cost for strategy: \$175,183; cost per student: very low when implemented in the high schools because of the large number of students expected to use the modules.

#### Web Based Course:

Web based Java programming course for high school students and teachers. This course was offered at no cost to the students (they bought a commercially sold book for \$10) and did not earn any academic credit. Students participated at their own pace and could quit at any time. Forty-two students enrolled for the first offering of this course in summer 2006. Several students expressed appreciation for the learning they achieved, but only one student completed all 16 homework assignments. Before offering the course again, we plan to find a way to encourage better participation for the course. Cost for strategy: \$18,200; cost per teachers: \$433. We anticipated larger enrollment for future implementations, and significantly lower cost per student.

### **Texas Tech University; Integrated, Seamless, Education System to Recruit and retain Students (003644-CS2003-0000)**

While the specific objectives of developing Web-based advising and mentoring tools have been completed or are near completion, the overall objective of increasing the number of computer science students has not been achieved. Several factors beyond the control of this grant have affected the system.

First, the crash in demand for computer science graduates has caused a general perception of fear in computer science as a major compared to other engineering majors. While our graduates get jobs, the perception of prospective students is caution and fear. This fear and decline in computer science majors seems to be a nation-wide trend.

Second, at the beginning of the grant, the Computer Science Department at Texas Tech University had a severe overload of students per number of faculty. Two solutions

to this problem were implemented: one addition of faculty, and two a focus to increase graduate students and research effort in the department instead of growing the undergraduate program. The formula funding process in Texas was a major factor for the department's goal to shift toward graduate programs (more funding for graduate students than undergraduate students).

The department also was successful in obtaining major grants from NASA that financially emphasized the graduate work over undergraduate work. The department has moved toward a more science based curriculum and away from software engineering and applied computer science. Thus, the current program is narrow and less attractive to a wide range of students than the program was a few years ago.

There is now a major concern about the declining undergraduate enrollment. There is also a relatively new Industrial Advisory Board, which should express needs of industry. Thus, there appears to be a high potential for the department to cycle back to a program with more appeal to perspective students.

Strategy one, to expand E-COACH to provide an integrated advising process, has been completed. The main work has been to improve COURSE Select to provide students with a long-term academic plan. This program works reasonably well for the computer science and other engineering degree plans. It has taken longer to complete this project than planned and it is too early to evaluate its value to improve student success. There is current interest in this program as a possible tool to be implemented across the university. The President and Provost have asked for a demo tentatively scheduled at the beginning of the fall semester. This program seems to fit well with the upper administration's plan for students to graduate on time. Thus, while we were not successful in raising enrollments, the foundational work to build a Web-based, integrated, seamless, education advising system has been successful.

The second strategy of increasing diversity was also addressed with this work. Demo and hands-on career assessment and recruitment were completed with high schools in Dallas and Houston. A special relationship was developed with Duncanville High School in the Dallas area to help them build a pre-engineering program. This school is rich in diversity and has the infrastructure to provide solid education in math and sciences and engineering. Administrative changes in the Dean's Office has changed policies for awarding scholarships which now limits the potential for this program to work.

### **The University of Texas at Austin; Recruiting and Retaining Computer Science Students (Turing Scholars Program) (003658-CS2003-0000)**

The Turing Scholars program was begun in 2002 as a new Honors Program in the Computer Sciences Department at UT-Austin. The inaugural class consisted of 44 competitively selected students from Texas. These students represented the best academically prepared students who had applied to the UT-Austin CS Department. The creation of this undergraduate honors program, the first in the history of our department, has had a profound and positive change on our overall program, our curriculum and our faculty. We graduated the first cohort of students in May 2006. The program is now an integral part of our undergraduate curriculum, and could not have happened without the TWD/TETC funding that was originally obtained to bootstrap this unique honors program. The following table shows the number of students who enrolled in the CS program as Turing Scholars per year, including internal admits (students who were Pre-CS majors and applied and were accepted into the program). We currently receive approximately 100 freshman applicants for this competitive honors program, and offer admission to approximately 50 per year but not all enroll at UT-Austin.

<b>Year Admitted</b>	<b>Number Enrolled</b>	<b>Graduated w/Honors</b>
2002	44	23
2003	44	2
2004	40	
2005	42	
2006	35	

Students enter the program directly into the CS major (rather than into the Pre-CS major as do regular students), and take two honors courses their first semester: CS313H (Discrete Math) and CS315H (Algorithms and Data Structures). They skip the first two semesters of introductory Pre-CS courses because of their advanced high school preparation. We have had a few students from the first and second cohorts graduate in 3 years, or chose to double major and graduate in 4 years with two degrees. The top Turing Scholar graduate in May 2006 (a female) was the commencement speaker for the College of Natural Sciences graduation ceremony and the top academic graduate of the College. She has entered the PhD program in CS at Stanford. Other students have obtained employment at Amazon.com, AMD (Austin), Google, IBM (Austin), Microsoft, National Instruments (Austin), NVIDIA, Sun (Austin), etc., and gone on to graduate school; e.g., UT-Austin, Berkeley, Stanford, CMU, MIT, and Wisconsin. Hence, we are meeting our primary criteria of success: graduation of a yearly cohort of top CS graduates who are regularly admitted to top graduate programs and are competitively hired into top jobs in the technology sector.

We have introduced a number of curriculum changes for this program and it took the first two years to work out the fine-grained details. Our initial courses were quite challenging, and some students dropped out of the honors program into the regular CS program or changed majors. We retuned the courses based on student feedback and course evaluations, and made instructor changes. We now believe we have the right mix of courses and excellent instructors for each and every course. Each year's students enter as a cohort and take a core set of required honors courses and choose a combination of honors and non-honors upper division electives, and a few take graduate level courses. All courses taught by CS faculty. Students are introduced to undergraduate research in their first year, and are required to take two semesters of undergraduate research starting in the junior year, culminating in a published Undergraduate Honors Thesis and a public oral defense with a committee of three professors in the junior/senior year. Many students are doing graduate quality research by the time they graduate.

The TWD/TETC startup funding for this program is primarily used for recruiting activities, freshman orientation programs, retention programs, and to support a student run Turing Scholars Student Association. We have solicited and received scholarships from corporations to be used for recruiting. Curriculum costs are now funded by the department. The ongoing retention programs are primarily supported by our normal academic budgets. We continue to use TWD/TETC funds for recruitment activities and we continue to seek much needed scholarship dollars in order to recruit and retain the best students in Texas. Because of the lack of scholarship dollars, we lose many to other top 10 CS programs in the US (e.g., MIT, Berkeley, CMU).

### **The University of Texas-Pan American; Increasing Computer Science Graduates and Enrollment through Learning Communities and Outreach (003599-CS2003-0000)**

The mentoring and learning community program implemented at The University of Texas – Pan American has proven to be a successful, cost effective strategy to increase retention among entering computer science students. Scholarships to community college transfer students have been effective in increasing upper level enrollment. The mentoring program implements widely used techniques, together with techniques adapted to the unique needs of students at this university. Its social elements address a critical need in the often difficult transition to university life often not explicitly addressed by university wide programs, but dealt with well at the small group and department level. The program has had a broad secondary impact on the department's student community.

The mentoring and learning communities program provides a series of activities that 1) introduce participants to the university's culture and processes, 2) provide ongoing tutorial support, 3) create opportunities for one-to-one interactions with faculty and successful upper class students, 4) supply less formal structures for social interaction, and 5) introduce students to university resources, such as financial aid and career placement. The program was able to attract highly qualified and dedicated student mentors. Key elements include the personalized experience in which peer and mentor support is available and introduction of participants to existing services and the computer science department community.

Two examples point out the utility in tailoring mentoring programs to individual institutional settings. A highlight of the past year's mentoring activities has been the involvement of the student professional organization. Upon funding of the program, the ACM student chapter was encouraged to participate through a range of activities, including subject-specific tutoring, presentations to mentoring groups, and hosting social events. The fit was good, with the upper level students finding an avenue for the service elements of their organization, as well as a group of enthusiastic students from which to recruit. The student organization has been vitalized in part from this set of experiences, culminating in the planning and implementation of a university wide "Computer Science Research Day" for which the students found sponsors, including IBM and Gateway, for speakers, food and all expenses for over 200 participants. Longer term, it seems likely that institutionalization of a mentoring program can be facilitated with such synergistic activities.

A second example of program adaptation was development of the "Computer Science Student Speaker Series". Mentors reported that there was a much wider interest in speakers for the mentoring groups than just entering students, e.g., speakers focusing on professional employment, university procedures such as financial aid, and reports of senior student research. Following up on the broader interest, mentors organized over each of the past two semesters a 12 speaker series addressing student interests. These broadly attended weekly events, which program participants are required to attend, have served as an important means to integrate entering students in the larger social and departmental contexts. Both of these examples point out the secondary impact of the mentoring program.

Key principles in efforts to achieve sustainability have been low cost, broad impact, and program design that facilitates institutionalization. Cost effective student effort is used to deliver most program services. By far the largest effort is in student-mentor contact hours, but effort in activities such as the speaker series and social engagement is also significant. The success of the program and the derivation of successful techniques appropriate for the institution have demonstrated the utility and cost-

effectiveness to others within the institution. Beginning next year, a portion of mentor effort will be funded internally. As noted above, student organizations might be drawn upon for student contact hours, as they become integrated and involved with the program. UTPA has recently opened the Office of Mentoring to complement a university wide learning community. As the office develops, it seems likely that it can take over or supplement mentor training.

For 2005-2006 mentoring participants, 88% continued and successfully completed the CS 1 course versus 58% for nonparticipants. Number of Progressing and Advanced students has increased significantly. Student participants and computer science faculty were surveyed and both groups reported that the program "was an important factor in successfully completing" the first programming course (94% and 100%, respectively) and "continuing study in computer science" (95% and 100%, respectively). All community college scholarship recipients are continuing their study in computer science. Cost per student participant was \$242 for the mentoring strategy and \$3800 for scholarships.

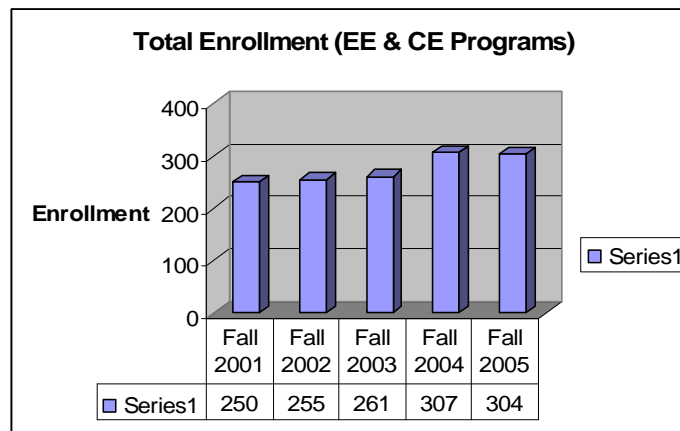
## TWD 2003 Electrical Engineering

### **Prairie View A&M University; Increasing the Quantity and Diversity of Students Pursuing Degrees in Electrical and Computer Engineering (003630-EE2003-0000)**

Electrical engineering undergraduate program at Prairie View A&M University (PVAMU) had an enrollment of over 500 students in 1991. In fall 2002, our enrollment has decreased to 255 students. We wanted to increase the enrollment through the following strategies: (i) increase retention rate, (ii) recruit high school students, and (iii) increase community college transfers.

Prairie View A&M University started using the Infinity Project in 2002. We created a course for the project in 2003. The course has been offered for eight consecutive semesters. The retention rate for the students who have taken the course is consistently beyond 80% for the past three academic years. To keep the retention rate high, we hired graduate and undergraduate students to mentor and tutor students at risk, especially freshman and sophomore students. The mentoring program together with the use of the Infinity project has helped us to achieve retention rate of 80% over the past years.

We visited high schools, offered design projects to high school students and have given talks to students in various high schools. Through our efforts, we have been able to increase our entering students for electrical and computer engineering programs. It was 97 during the fall 2003 semester. During fall 2004 semester, our entering students' enrollment was 122. However, during the fall 2005 semester, our entering students' enrollment dropped to 101. This is because the College of Engineering and Prairie View A&M University instituted higher admission standards for freshman students. However, the total enrollment for both the electrical and computer engineering programs has been increasing during the past three years. The figure below shows the electrical and computer engineering enrollment.



It is reported that majority of high school graduates attend community colleges instead of four-year academic institutions. In most cases, community college students can transfer to universities and complete their baccalaureate degrees within two or three years. We wanted to attract the community college students to Prairie View A&M University by offering them scholarships. Because of funds available for scholarships in TWD Project Number: 003630-EE-2002-0000, we have so far not awarded any transfer students' scholarship from this grant. The amounts of money spent on various

strategies are: (i) increase retention rate, \$14,227; (ii) recruit high school students, \$9,800; and (iii) scholarship for transfer students, \$0.00.

### **Southern Methodist University; SHinE: Strengthening Hispanics in Engineering (003613-EE2003-0000)**

The Strengthening Hispanics in Engineering (SHinE) program seeks to increase enrollment, retention, and graduation rates of Hispanic students in the Electrical Engineering Department at Southern Methodist University. Currently, there are 98 undergraduates enrolled in the EE department. Hispanics currently make up 32% of the total population in Texas, yet they account for only 3.5% of the engineering workforce nationally. In the Electrical Engineering Department at SMU, Hispanics make up 11% of total enrollment, while only 30% of entering Hispanics go on to graduate. Non Hispanic students, on the other hand, have a 50% graduation rate.

In order to overcome these issues, we have been attempting to introduce both tutoring and mentoring in our undergraduate EE courses which have traditionally shown a high attrition rate, particularly among minority students. During the Spring '05 semester, we held weekly help sessions for the course EE 2370, "Design and Analysis of Signals and Systems". This semester we plan to hire undergraduate tutors who will help students with academic problems as well as serve as mentors. These students will be recruited and trained by the Learning Enhancement Center. Hiring of minority tutors/mentors will be emphasized.

Our initial efforts in this area involved hiring a TA to hold weekly help sessions in our EE 2370, "Design and Analysis of Signals and Systems" course. We do not have any objective measure of the result of the help sessions. We do have some qualitative observations made by students who attended the help sessions. Among these are:

*"She is very helpful and made sure everyone understood the material."*

*"Wonderful job."*

*"Enthusiastic about the course. Helps clarify our doubts."*

*"Very helpful outside of class and wrote many helpful remarks when grading papers, often working the entire problem for the student to see. Noha always pushes for quality work."*

An Engineering Application Bootcamp was held. This outreach event was designed to foster interest in engineering careers. Currently, we are implementing a tutoring and mentoring program in conjunction with the local student chapter of the Society of Hispanic Professional Engineers (SHPE).

### **Texas A&M University-Kingsville; Expansion of the EE Program at TAMUK with Scholarships and Tutoring (003639-EE2003-0000)**

#### **Student Recruitment**

We proposed to visit high schools in South Texas to recruit students. We sent selected senior students to their respective alma mater to talk to high school students about electrical engineering in term of what they learned and their experiences as engineering students, etc. It was important since many high school students in this area do not know what electrical engineers do. High school students in all four years, especially students in math and science clubs and/or J.E.T. club, were audiences for such visits. High school visitation did not cost much. When they went with the College of Engineering recruiter, the transportation and lunch were usually provided for them. For recruiting purposed, scholarships were given to fourteen freshmen and transfer

students from community colleges. Cost for strategy: \$24,000; cost per student: \$1,500 (scholarship), \$100 (travel)

#### Student Retention

We have developed 2+2 programs with several community colleges in South Texas. The fact that no sophomore major courses were offered in the community colleges has been a major hindrance to keep students in 2+2 programs in the community colleges and this affected the retention rate negatively. During the 2004-2005 academic year, we offered one sophomore course, Digital Logic Design, via TTVN for students who are in the 2+2 programs at Del Mar College, South Texas Community College and Palo Alto College. About 12 students took advantage of it. We plan to add more courses so that the students in the community colleges can finish their first two years of the program without commuting or relocating to Texas A&M University-Kingsville.

#### Student Mentoring

We hired six student tutors in the fall 2004 semester and seven student tutors in the spring 2005 semester. During the afternoon and evening hours, these tutors were available for tutoring lower-class electrical engineering students. More than five students a day visited the tutor room to get help. Cost for strategy: \$24,000; cost per student (both tutors and lower-class student): \$1,000

#### Follow-up Funding

We received a grant from National Instruments for 10 NI ELVIS workstations with necessary DAQ (data acquisition) hardware and LabView software for development of a digital measurement laboratory. These are being used in EEEN 3212 (Circuits and Electronics Lab).

The electrical engineering enrollment has increased by three students between 2003 and 2005 while the enrollment in electrical engineering in Texas has dropped during the same period.

### **Texas Engineering and Experiment Station; Improving the Quality, Quantity and Diversity of Electrical and Computer Engineering Graduates (010366-EE2003-0000)**

At the heart of the TWD 2002 effort, there were essentially two core strategies. First was the enhancement of curriculum and participation of senior faculty champions to orchestrate this vision. The second was improving methodology of instruction, including design studio and mentoring of students by faculty, graduate students and peer teachers. The basic premise was that if the students could be interested and challenged, they will stay, and more will come through enhanced reputation of the program. With success of the TWD2002 efforts, these two core strategies were continued and expanded to higher level courses including introduction of honor courses in TWD2003 effort. Faculty champions were selected for each area and given appropriate resources to accomplish their tasks.

Restructuring of the freshman level first course in engineering, ENGR111, was finalized and implemented. A survey of the students had concluded that the manner this class was taught in the past did not serve to motivate and excite students about Electrical or Computer Engineering. Based on our experience with an experimental optional freshman course in engineering using robotic material, it was decided to restructure and offer a special ENGR 111 for all those interested in electrical or computer engineering. This class is 2-hour lecture and two-hour lab. The students are introduced to what electrical and computer engineers do, taught basic technologies and presented a four year road map of their education. The class also emphasizes the role of design in engineering and calculations are tied to measurements. The whole teaching

philosophy is centered on “understand and apply” rather than “memorize and reproduce.” Theory is connected to practice through labs that are currently using OGS Tekbots as a vehicle.

Funds from the TWD grant also enabled a number of new developments for a core junior-level course related to engineering system and signal design, ELEN314. First, a major curriculum change to the course was facilitated in which content that was primarily circuit-based was updated to include concepts from signal processing and linear system analysis. By evaluating the course content of many quality programs, it has become clear that modern electrical and computer engineering curriculum should be, in part, “signals and systems”-centric. The increased theoretical content necessitated the introduction of practical assignments in the course to motivate more hands-on work for students. Matlab assignments were created based on image processing applications. Later, LabVIEW assignments were introduced along with a series of five interactive demos. The interactive format allows students to play around with the theoretical ideas in a practical application-framework elucidating the material. Finally, to provide support for abstract problem solving, the number of contact hours for the course has been increased from 3.0 hours per week (of lectures) to 4.0 hours per week (3.0 hours of lectures + 1.0 hours of recitations). The addition of recitations in the course has made it possible to introduce metacognitive approaches to problem solving. Metacognition is the process of teaching students how to learn on their own by allowing them to develop an internal dialogue of questions that facilitates independent learning. Performance in the course has improved on tests due to the addition of these recitations making it possible to challenge the students to a greater degree theoretically.

Capstone Design Course, ELEN 405 has been greatly improved by setting up a well equipped laboratory and soliciting sponsored design projects from the industry. The design projects are demonstrated every semester with a view to exposing the freshman and high school students to interesting things that electrical and computer-engineering offers. Other next level courses that have been enhanced include ELEN 325: Electronics and ELEN 322: Electromagnetic Theory. In addition a course related to engineering systems and biological systems has been offered to enhance the appeal of the curriculum to students, especially female students. The demand for courses in electric energy systems has increased due to focus on energy, so a course on electric power is also targeted for enhancement.

Another accomplishment under the TWD grants is the start of honors courses with the ultimate goal of establishing an ECE Honors track. The main objective is to offer challenging electrical engineering curriculum to upper GPA students. Honors sections emphasize participatory discussion and new laboratory experiments in which the students choose their design to meet a set of specifications. Several Honor courses have been offered and more are expected to be offered. We expect to be able to recruit more students, especially with higher GPA by providing more options like honors track. It is our understanding that curriculum with more choices attracts more students.

In addition to curriculum and instruction, we taught special section of digital system with special consideration of underrepresented students, sent an ambassador student to high schools and sent poster invitations to high school advisors across Texas.

As has been described under the progress report of 2002 TWD grant, the TWD funding has helped increase and stabilize the number of graduates by about 50% despite an over all decline in enrollment consistent with the national trend. Efforts are now being made to increase the enrollment in the coming years.

### **Texas Tech University; Electrical Engineering Recruitment and Retention at Texas Tech (003644-EE2003-0000)**

Three strategies were proposed for recruiting and retention of Electrical and Computer Engineering students. The three strategies are: freshman curriculum improvement, high school outreach through pre-engineering course development, and expansion of the undergraduate research programs established during the first round of funding.

The first strategy, freshman curriculum improvement, addresses retention of incoming students in their first year. Exposing students to the Electrical Engineering discipline in their first semester helps ensure their success very early. We developed a freshman course in electrical and computer engineering that students take in their first semester. The course has an integral laboratory component during which students work on projects associated with course lectures under the direction of graduate student assistants. The course provides an exciting introduction to several areas in electrical and computer engineering in order to stimulate students' interest in the discipline. It also provides them with skills that are highly beneficial in later courses. This course also ensures contact with Electrical and Computer Engineering Faculty as soon as students start their undergraduate studies. It is usually taught by some of the best instructors in the department who won several teaching awards. This strategy was very successful since course passing rates are much better than those in the old introductory course in addition to very positive student comments indicated in the students' evaluation of instruction. This strategy affects all freshman students. Its proposed cost was \$36,643.

The second proposed strategy deals with outreach to high schools to help them develop their pre-engineering courses, possibly using our freshman introductory course as a basis. This strategy is still being implemented with successes expected in the coming year. We delayed major work on this strategy because the federal portions of the three TETC grants we received expire by the end of this summer, and since federal guidelines do not allow expenditure on high schools, we concentrated our efforts on the other strategies in the three TETC grants that concentrate on post-secondary education only. We will focus on this strategy this coming year. Proposed cost of this strategy was \$99,638.

The third strategy addresses retention of students at all levels by continuing and expanding the undergraduate summer research program that we established during the first round of funding of the TWD program. This strategy insures the continuation of this highly successful summer program and seeks to expand it by providing research opportunities to our undergraduate students during the academic year as well. This strategy helps increase retention by improving the quality of our undergraduate experience and it provides our students with skills and expertise that are not normally attainable from a typical electrical engineering curriculum. Students participate in ongoing research and development projects in the department under the supervision of full time faculty during the summer or the academic year. So far, more than 55 students and 9 faculty members participated in this program (funded by this grant and the other two TWD grants). Each participating student is required to make a final presentation and submit a final report summarizing their work. This strategy is highly successful. All students who participated in this program are either progressing well or have already graduated and now working in industry or pursuing graduate work. The proposed cost of this strategy was \$119,281.

## **University of Houston; Undergraduate Retention and Recruiting of ECE Students at the University of Houston (003652-EE2003-0000)**

### Student Recruitment:

University of Houston Electrical and Computer Engineering department (ECE) has sponsored 14 weeklong engineering GRADE camps for female high school students (305 attendees) since 2003. We designed our curriculum from a theory into practice model. Specifically, the girls learned engineering principles, such as voltage and current, motors and generators, feedback control, and problem solving, during the mornings and applied their knowledge in the afternoons to program, design, and build a Lego robot that autonomously navigated a maze by the end of the week. We designed the lunch sessions so that the girls would have ample opportunities to carry on candid and engaging conversations with female engineering students (both undergraduate and graduate), engineering faculty and engineers working in the Houston area. At the end of the week, the girls invited their parents, teachers, and invited guests to their presentations, see their root demonstrations and join them at a formal luncheon, which included a scheduled guest speaker and an awards ceremony. Cost: \$58,000 and cost per student: \$725.

### Student Retention:

University of Houston ECE has sponsored the Redshirt Camp curriculum for ECE sophomores (300 attendees) every semester since 2003. ECE formulated a curriculum that was challenging and required a significant amount of student group work. Our goal for the camps was not to expose students to the first two weeks of difficult course material, but rather, to give them experience using novel problem solving techniques that they can use for any future class, research, and work situation. Most indicated that they enjoyed working in peer groups to solve problems, interacting with faculty, solidifying their knowledge about fundamental concepts underlying their Circuits and Electromagnetics courses, and learned about effective time management skills. In addition, ECE Workshops allow Redshirt Camp participants the opportunity to apply Redshirt Camp principles their Circuits or Electromagnetics course throughout the subsequent semester, while providing an atmosphere conducive to productivity through group problem solving. Over the past three academic years, 51% of the Circuits course students, who did not participate (no intervention) in the Redshirt Camps and Workshops, passed the course. The pass rate for the Circuits course students who attended Redshirt Camp and Workshops (intervention) was 70%, compared to a 96% pass rate for students who were enrolled in Redshirt Camp and the Workshops. In total, we have seen vast increases in pass rates for our “intervention” group. Additionally, it should be noted that there has been no statistical difference in the GPAs for participants and non-participants, meaning students have not self selected based on prior academic performance. Therefore, we believe the Redshirt Camp plus workshop can and do improve retention rates in these rigorous courses. Cost: \$87,000; cost per student: \$725.

ECE undergraduate enrollment experienced a dramatic increase in enrollment Fall 2001. The minimum GPA requirement for transfer students was raised from 2.0 to 2.5 in 2003, resulting in fewer transfer students enrolling in ECE recently; thus, accounting for the “dip” in the number of ECE students. ECE graduates have doubled since Fall 2001.

### Curriculum Changes:

ECE 2300 (Circuits) and ECE 2317 (Electromagnetics): We added workshops outside of lecture hours and added to the original number of lecture sections offered.

### Leverage of Grant Funds (Follow-up Funding):

National Science Foundation (NSF) grants to help sustain our ECE recruitment and retention efforts: *STEP-AHEAD: Access to Higher Education through Academic*

*Retention and Development at the University of Houston, 12/01/03 – 11/30/08, \$1,660,449.*

RET Site: Research Experiences for Greater Houston high School Science and Math Teachers, 10/01/03 – 09/30/07, \$435,530.

Gifts to help sustain ECE recruitment: *Exxon-Mobil* (\$40,000) and *Texas Instruments* (\$5,000).

**The University of Texas at Arlington; Recruitment and Retention to Increase the Number of Undergraduate Students in the Electrical Engineering Program (003656-EE2003-0000)**

The three approaches for increasing the number of electrical engineering (EE) graduates were to improve recruiting, retention and placement rates. To improve recruiting, we planned to partner with local school districts and interest students in EE and in particular, UTA. To achieve this, Mr. Bernard Svihel became very involved with the Mansfield School District by being present at College Days and civic functions with information booths and interesting demonstrations of electrical devices and phenomena. In addition, the College of Engineering at UTA has better coordinated much of the math, science and lower-division engineering courses with local community colleges such as DCCC and TCC. Through this effort we are attempting to engage these students earlier by encouraging dual enrollment so they can take essential freshman courses at UTA while getting much of the math, science and liberal arts sections of the curriculum at the community colleges. The students' cost differential between UTA courses and community college courses is significant. However, the cost of maintaining contacts with area high schools and coordinating the curriculum with the community colleges is minimal for UTA.

The second approach for increasing the number of EE students is to improve retention rates. We offered some 1-year scholarships to students who had demonstrated superior ability. This is a relatively expensive retention strategy in that the cost per student affected is high. The scholarships awarded were funded from a different contract. The most cost effective plan for retention has been our student mentoring office. Its daily operation is largely managed by the student chapter of IEEE and is financially supported by this project. Student mentors are paid on an hourly rate to be available throughout the week to all students taking EE classes. The mentors advise students on homework problems, project assignments and provide review sessions before exams. The EE department additionally supports this operation by providing a graduate student manager from the GTA budget. Also, most GTA's are required to commit half of their office hours to the mentoring office. In this manner, we intend to continue the operation of the mentoring office beyond the life of this project. The estimated average project cost per student based on students helped and mentoring office expenses is \$45. This is spread over many visits.

The third approach to increasing EE throughput is to assure that students who graduate are readily employed in their profession. Industry has been helpful by hiring our graduates and providing summer internships. Out student professional societies have assisted by organizing job fairs and plant visits. In addition, graduates established in industry have provided programs for student chapter meetings. Accordingly, placement of our graduates has been successful at little actual monetary cost to the program. Sustainability has been achieved by establishing these practices in our student groups.

Summary of Accomplishments

- Establishment of the IEEE Student mentoring Office

- Improved liaison with area high schools
- Conference paper: Wright and Thakkar, 2004

### **The University of Texas at El Paso; Creating Learning Communities at UTEP to Increase Throughput (003661-EE2003-0000)**

The targeted group to benefit from the TWD project in the University of Texas at El Paso is sophomore level electrical and computer engineering students who are entering two required gatekeeper courses, Digital System Design 1 and Networks 1. The majority of the students are minority populations such as Hispanic, African American and Native American. It is essential that students successfully complete these gatekeeper courses in order for the students to progress to their upper level courses and move on to earn their degree.

Targeted students were exposed to active and cooperative learning approaches in weekly laboratories that were approximately 2 hours long and focused on peer learning; previously the Digital Systems Design did not have a laboratory session and Networks 1 Laboratory did not incorporate cooperative learning. A two day workshop on cooperative learning, prior to beginning the semester, is offered for faculty and staff members who are participating in the project so that they can effectively utilize and impart these teaching and learning techniques. During the course of the semester, frequent reports were required from peer-facilitators regarding the effectiveness of each session and any new improvement needed for future sessions.

Research indicates that these types of teaching/learning approaches are effective. According to a case study conducted by Mourtos, N. J., 1997 (The nuts and bolts of cooperative learning in engineering. *Journal of Engineering Education*, 86(1), 35-37), an increase in student success in problem solving was evident in students who participated in cooperative learning. Other research supported by Courtney, D. P., Courtney, M., and Nicholson, C., 1994 (The effect of cooperative learning as an instructional practice at the college level. *College Student Journal*, 28, 471-7) found that about 96% of the students who participated in cooperative learning in their class commented that they had more support from their peers and mentors which led to a decrease in anxiety over the course contents, while other findings (Nath, L.R., Ross, S., and Smith, L., 1996, A case study of implementing a cooperative learning program in an inner city school. *The Journal of Experimental Education*, 64, 117-36) suggested that students who participated in cooperative learning also had a positive increase in student communication and social skills. These findings correlate to the research done at our University as students had often commented on their sessions being more “relaxed” as they were able to freely ask one another questions without anxiety.

The TWD induced transformation of these ‘gatekeeper’ to ‘gateway’ courses has had various benefits, among them students earned higher grades, developed new learning strategies, and experienced a positive outlook on their education and in their future career as an engineer. Another direct benefit was increased retention in the program leading to increased advancement and graduation as indicated by the upward trend in the number of students progressing, advancing, and graduating (the number of students advancing has gone from 59 in the Fall of 2003 to 100 in the Fall 2005). Over 430 students have benefited from taking these courses over the lifetime of the project, a little over \$300 has been invested in these students so far; this is without counting the number of students who have participated as peer leaders and teaching assistants for these classes. The project was entirely designed to provide support to progressing students, since this project is concentrated on reforming two critical sophomore level courses, so that they may advance and graduate. From the positive results obtained

and after meeting with the ECE faculties and the Dean of Engineering it was concluded that the program will be institutionalized.

### **The University of Texas-Pan American; On-Campus Jobs for Electrical Engineering Retention (003599-EE2003-0000)**

#### Strategies:

This project was centered primarily on a single strategy, an on-campus jobs program providing on-campus technical employment to new electrical engineering students in order increase presence and engagement on campus, provide financial support, and reduce time conflicts due to external employment. This strategy was tested during the first year of the our TWD 2002 project, and the first cohort of students in the on-campus employment program had a one-year retention rate of over 95%, compared to a University average of less than 70% over the same period. A small amount was expended for targeted summer scholarships supporting students taking specific calculus and engineering courses. The combined 2002 and 2003 TWD on-campus employment projects had a total of 78 students participating, many of them as starting as Entering students and then continuing to participate as Progressing and Advanced students.

Out of the 78 participants over four years, 24 have graduated with BSEE degrees, 41 remain students in good standing in the BSEE program, 4 are currently students are in good standing in other engineering/CS majors, 3 are students in good standing in non-technical majors, 2 left the university to transfer to other institutions, and 4 have left the university or are not in good standing. Considering the broader TWD objective of promoting engineering and computer science, this is a cumulative success rate of 88%. Comparable statistics for the University as a whole are in the range of 50-55%. Graduates of the program are currently employed at Texas companies including Texas Instruments, Raytheon, IBM, and Lockheed-Martin, and many of the current participants had internships during Summer 2005 and 2006.

#### Enrollment/Graduation:

Total enrollment in electrical engineering experienced a decline from 273 in Fall 2003 to 233 in Fall 2006, due to a decline in entering freshmen; however, the number of graduates increased from 22 per year to 30 per year over the same period. Enrollment in upper division courses, and the number of engineering hours taken per semester per student, increased over the period of the project. This data indicates that we have had a very substantial gain in retention and graduation rates, but that recruitment of high school students into electrical engineering is a major problem area.

#### Cost per strategy and per student:

In the TWD 2003 effort, approximately \$62,200 has been spent on the on-campus job program; \$4,000 on scholarships; and \$200 on operating expenses (primarily postage and forms). Approximately 85 students were directly benefited by the combined TWD 2002 and 2003 projects, at a cost of \$3,501 per student for TWD 2002 and 2003 combined, and \$782 for TWD 2003 alone. The cost of the on-campus job program was typically \$2,700 per student per year.

#### Sustainability and Leverage of Grant Funds:

The PIs have submitted grant proposals for external funding to continue the on-campus jobs program, and plan to continue to do so. A limited number of undergraduate participants will be transitioned in Fall 2006 and Spring 2007 to support from research projects. The School of Engineering and Computer Science has endowed scholarships that will continue to support 50-60 students per semester.

### **The University of Texas at San Antonio; Improving Retention in Electrical Engineering Using Programmable Logic Devices (010115-EE2003-0000)**

The single most important objective of this proposal is to promote the Technology Workforce Development Act by increasing the number of high-quality graduates who are technically competent and competitive in the nation. In order to achieve this objective, the department of electrical engineering at the University of Texas at San Antonio proposed to develop a programmable logic-based curriculum at UTSA. The end results we had hope to achieve are: increased retention rate, increased number of graduates, and most importantly improved quality of competent graduates entering the technology workforce. The Field Programmable Gate Arrays (FPGA) based and Complex Programmable Logic Device (CPLD) based evaluation kits were to be used to conduct experiments in our Sophomore and Junior level courses.

Prior to this project, the sophomore level course EE 2513 (Logic Design) did not have any laboratory component. Starting Fall 2003, we adopted a new edition of the book, which includes hardware modeling concepts. The course material was revised to add at least two laboratory assignments which were simulation based. These laboratory assignments were conducted during the recitation session and the simulation tools were used. The proposal allowed us to use CPLD kits in the class starting Fall 2004. In Fall 2005, additional laboratory assignment was introduced in the class. The acceptance of the laboratory assignments and feedback from the students led us to introduce a new laboratory course, EE 2511, which will run with the EE 2513 course concurrently starting Fall 2006. This course will have eight laboratory assignments. Students design combinational and sequential network designs and verify their design through the CPLD-based evaluation kits hardware.

Using experience gained through the required sophomore class, subsequent junior-level course, EE 3563 (Digital Systems Design), was revised to include hardware component using FPGA development kits. The FPGA kits were procured and used in the class starting Fall 2005. The course material was revised to include advanced topics such as FPGA architecture, testbenches and state machines modeling. Additional laboratory assignments are conducted using simulation tools.

We feel that the project has positive impact as over 200 students were trained with a latest technology. They were provided opportunity to develop skills necessary to become a better design engineer in a technology oriented taskforce.